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PHYS 252 HW 6

Problem 8.2 $y = A + Bx$ $(-3,3), (-1,4), (1,8), (3,9)$ $N = 4$

$A = \dfrac{\sum x^2 \sum y - \sum x \sum xy}{\Delta}$

$B = \dfrac{N\sum xy - \sum x \sum y}{\Delta}$

$\Delta = N\sum x^2 - (\sum x)^2$

Δ: $\sum x^2 = (-3)^2 + (-1)^2 + (1)^2 + (3)^2 = 20$

$9 + 1 + 1 + 9$

$\sum x = -3 - 1 + 1 + 3 = 0$ $(\sum x)^2 = 0$

$\Delta = 4(20) - 0 = 80$

$\Delta = 80$

A: $\sum x^2 = 20$

$\sum y = 3 + 4 + 8 + 9 = 24$

$\sum x = 0$

$\sum xy = (-3)(3) + (-1)(4) + (1)(8) + (3)(9) = 22$

$-9 - 4 + 8 + 27$

$A = \dfrac{20(24) - 0(22)}{80} = 6$

$A = 6$

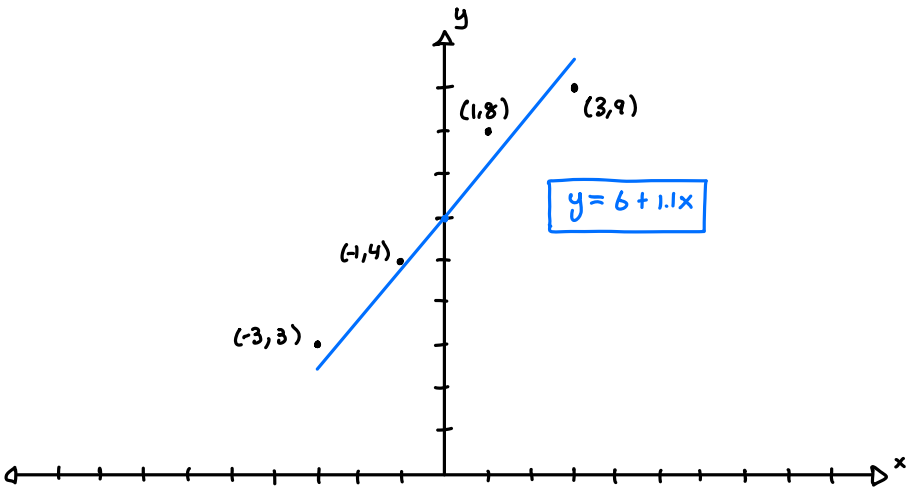
B: $\sum xy = 22$

$\sum x = 0$

$\sum y = 24$

$B = \dfrac{4(22) - 0(24)}{80} = \dfrac{88}{80} = 1.1$

$B = 1.1$



Problem 8.7

$y = A + Bx$ $\quad l = l_0 + (g/k)m$

"x": Load m (grams) :	200	300	400	500	600	700	800	900	$N = 8$
"y": Length l (cm) :	5.1	5.5	5.9	6.8	7.4	7.5	8.6	9.4	

$\Delta = N\sum x^2 - (\sum x)^2$

$A = \dfrac{\sum x^2 \sum y - \sum x \sum xy}{\Delta}$

$B = \dfrac{N\sum xy - \sum x \sum y}{\Delta}$

Δ : $\sum x^2 = (200)^2 + (300)^2 + (400)^2 + (500)^2 + (600)^2 + (700)^2 + (800)^2 + (900)^2$

$\sum x^2 = 2.84 \times 10^6$

$\sum y = (5.1) + (5.5) + (5.9) + (6.8) + (7.4) + (7.5) + (8.6) + (9.4)$

$\sum y = 56.2$

$\sum x = (200) + (300) + (400) + (500) + (600) + (700) + (800) + (900)$

$\sum x = 4400 \quad : \quad (\sum x)^2 = 1.936 \times 10^7$

$\Delta = 8(2.84 \times 10^6) - (1.936 \times 10^7) = 3.36 \times 10^6$

A: $\sum x^2 = 2.84 \times 10^6$

$\sum y = 56.2$

$\sum x = 4400$

$\sum xy = (200)(5.1) + (300)(5.5) + (400)(5.9) + (500)(6.8) + (600)(7.4) + (700)(7.5) + (800)(8.6) + (900)(9.4)$

$\sum xy = 33,460$

$A = \dfrac{(2.84 \times 10^6)(56.2) - (4400)(33,460)}{3.36 \times 10^6} = 3.685 \approx 3.69 \text{ cm}$ $\quad \boxed{A = 3.69}$

B: $\sum xy = 33,460$

$\sum x = 4400$

$\sum y = 56.2$

$B = \dfrac{8(33,460) - (4400)(56.2)}{3.36 \times 10^6} = 0.006071$ $\quad \boxed{B = 0.006071}$

$l = 3.69 \text{ cm} + (0.006071)m \longrightarrow l_0 = 3.69 \text{ cm}$

$mg = k(l - l_0)$: $k = \dfrac{mg}{(l - l_0)}$ $\quad m = \dfrac{k(l)}{g}$ $\quad kg = \dfrac{x\,(m)}{m/s^2}$: $kg = x\,s^2$ $\quad N = kg \cdot m/s^2$

$x = kg/s^2 = N \cdot m$

$g = 9.80 \text{ m/s}^2$

$l_0 = 0.0369 \text{ m}$

$\bar{k} = \dfrac{\sum k}{N}$ $\quad N = 8$

$m = 0.2$ kg	$l = 0.081$ m	: $k_1 = 139.007$ N/m
$m = 0.3$ kg	$l = 0.065$ m	: $k_2 = 162.431$ N/m
$m = 0.4$ kg	$l = 0.089$ m	: $k_3 = 177.736$ N/m
$m = 0.5$ kg	$l = 0.068$ m	: $k_4 = 157.556$ N/m
$m = 0.6$ kg	$l = 0.074$ m	: $k_5 = 158.491$ N/m
$m = 0.7$ kg	$l = 0.075$ m	: $k_6 = 180.092$ N/m
$m = 0.8$ kg	$l = 0.086$ m	: $k_7 = 159.674$ N/m
$m = 0.9$ kg	$l = 0.094$ m	: $k_8 = 154.466$ N/m

$\bar{k} = 139.007 + 162.431 + 177.736 + 157.556 + 158.491 + 180.092 + 159.674 + 154.466$ N/m

$\bar{k} = 161.132$ N/m

$\boxed{l_0 = 3.69 \text{ (cm)} \quad k = 161 \text{ N/m}}$

Problem 8.15 $S_n = A + Bn$ $B = \lambda/2$ $y = A + Bx$

"x": Node number n :	1	2	3	4	5	6	$N = 6$
"y": Position S_n (cm) :	5.0	14.4	23.1	32.3	41.0	50.4	

$$A = \frac{\sum x^2 \sum y - \sum x \sum xy}{\Delta} \qquad \sigma_y = \sqrt{\frac{1}{N-2}\sum_{i=1}^{N}(y_i - A - Bx_i)^2}$$

$$B = \frac{N\sum xy - \sum x \sum y}{\Delta} \qquad \sigma_A = \sigma_y\sqrt{\frac{\sum x^2}{\Delta}}$$

$$\Delta = N\sum x^2 - (\sum x)^2 \qquad \sigma_B = \sigma_y\sqrt{\frac{N}{\Delta}}$$

Δ: $\sum x^2 = (1)^2 + (2)^2 + (3)^2 + (4)^2 + (5)^2 + (6)^2 = 91$

$\sum x^2 = 91$

$(\sum x)^2$: $\sum x = 1+2+3+4+5+6 = 21$

$(\sum x)^2 = (21)^2 = 441$

$\Delta = 6(91) - 441 = 105$

$\Delta = 105$

A: $\sum x^2 = 91$

$\sum y = 5.0 + 14.4 + 23.1 + 32.3 + 41.0 + 50.4 = 166.2$

$\sum y = 166.2$

$\sum x = 21$

$\sum xy = 1(5.0) + 2(14.4) + 3(23.1) + 4(32.3) + 5(41.0) + 6(50.4) = 739.7$

$\sum xy = 739.7$

$$A = \frac{91(166.2) - (21)(739.7)}{105} = -3.90$$

$\boxed{A = -3.90}$

B: $\sum xy = 739.7$ $\sum x = 21$ $\sum y = 166.2$

$$B = \frac{6(739.7) - (21)(166.2)}{105} = 9.03$$

$\boxed{B = 9.03}$

$\boxed{S_n = -3.90 + 9.03(n)}$

$$\sigma_y = \sqrt{\frac{1}{N-2}\sum_{i=1}^{N}(y_i - A - Bx_i)^2} \qquad \sigma_B = \sigma_y\sqrt{\frac{N}{\Delta}}$$

$$\sum_{i=1}^{6}(y_i + 3.90 - 9.03(x_i))^2 = 0.1689 \qquad \sigma_y = \sqrt{\frac{1}{6-2}(0.1659)} = 0.2037$$

$i=1$: 0.0169

$i=2$: 0.0576

$i=3$: 0.0081

$i=4$: 0.0064

$i=5$: 0.0625

$i=6$: 0.0144

$$\sigma_y = \frac{0.204}{2} = 0.102 \approx 0.1 \qquad \sigma_B = 0.1$$

$B = \frac{\lambda}{2}$: $\lambda = 2B = 2(9.03\text{ cm}) = 18.06\text{ cm} \approx 18.1\text{ cm}$

$\lambda = 18.1 \pm 0.1\text{ cm}$

$S_n = -3.90 + 9.03n$

$A = -3.90$, $B = 9.03$

$\lambda = 18.1 \pm 0.1\text{ cm}$